

In re Patent Application of:

**STORM ET AL.**

Serial No. **10/820,464**

Filed: **APRIL 8, 2004**

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#### REMARKS

Applicants would like to thank the Examiner for the thorough examination of the present application.

The independent claims have been amended to more clearly define the present invention over the cited prior art references. Support for the claim amendments is best illustrated in FIG. 3.

The Examiner objected to independent Claims 14, 21 and 31 as being indefinite based on whether or not the readout switch and the log select switch share the same control terminal. As best illustrated in FIG. 3 in the Applicants' specification, the readout switch **M2** and the log select switch **M6** do not share the same control terminal. In the claimed invention, the log select switch **M6** includes a control terminal to receive a log select signal (logsel). The log select switch **M6** also includes a pair of conducting terminals connected between the output of the amplifier and the control terminal of the readout transistor **M2**. Consequently, the control terminals for the log select switch **M6** and the readout switch **M2** are not the same.

The claim amendments and arguments supporting patentability of the claims are provided below.

#### I. The Amended Claims

The present invention, as recited in amended independent Claim 14, for example, is directed to an image sensor comprising an array of pixels, with each pixel comprising a photodiode, and a first output circuit for deriving a linear

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output signal by applying a reset signal to the photodiode and reading a voltage on the photodiode after an integration time. The first output circuit comprises a reset switch for applying a reset voltage to the photodiode. The reset switch comprises a reset transistor including a conducting terminal connected to the photodiode. A readout switch turns on the conducting terminal of the reset transistor after expiration of the integration time. The readout switch comprises a readout transistor including a conducting terminal connected to the conducting terminal of the reset transistor and to the photodiode, and includes a control terminal.

A second output circuit derives a logarithmic output signal by reading a near instantaneous illumination-dependent voltage on the photodiode that is a logarithmic function of the illumination. The second output circuit comprises an amplifier including an output and at least one input connected to the conducting terminal of the reset transistor, to the conducting terminal of the readout transistor and to the photodiode, and a log select switch for connecting the amplifier to the photodiode. The log select switch comprises a log select transistor that includes a pair of conducting terminals connected between the output of the amplifier and the control terminal of the readout transistor, and also includes a control terminal to receive a log select signal. The first and second output circuits sequentially provide the linear and logarithmic output. An output selection circuit is coupled to the array of pixels for selecting between the linear output signal and the logarithmic output signal as an output signal.

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Independent Claim 21 is directed to an image sensor, and has been amended similar to independent Claim 14.

Independent Claim 31 is directed to a method for operating an image sensor, and has been amended similar to independent Claim 14.

## **II. The Claims Are Patentable**

The Examiner rejected independent Claims 14, 21 and 31 over the Morris et al. patent in view of the He et al. patent and in further view of the Hagihara patent.

The Examiner referenced FIGS. 3 and 4 in Morris et al. as disclosing an image sensor **140** comprising an array of pixels **119**, with each pixel comprising a photodiode **152**. The Examiner referenced column 5, lines 34-35 as disclosing the image sensor operating in the logarithmic mode, and column 6, line 13 as disclosing the image sensor operating in the linear mode. A multiplexing circuit **127** is configured as an output selection circuit for selecting between the linear mode and the logarithmic mode (column 6, lines 8-15).

For the first output circuit, the Examiner broadly characterizes reference elements **124** and **129** in FIG. 3 as the reset switch and the readout switch. In particular, the Examiner characterizes transistor **150** in FIG. 4 as the reset transistor including a conducting terminal connected to the photodiode **152**. For the second output circuit, the Examiner characterizes reference elements **156** and **160** in FIG. 4 as the amplifier and the logic select switch. When the logarithmic mode is asserted, a

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voltage  $V_G$  is applied to the transistor **150** and then the node **160** serves as the log select switch.

As correctly noted by the Examiner, Morris et al. fails to disclose the readout switch within the first output circuit comprising a readout transistor including a conducting terminal connected to the conducting terminal of the reset transistor, and including a control terminal. Also as correctly noted by the Examiner, Morris et al. fails to disclose the log select switch comprising a log select transistor including a pair of conducting terminals connected between the output of the amplifier and the control terminal of the readout transistor, and including a control terminal to receive a log select signal.

The Examiner referenced FIG. 2 in Hagihara as disclosing the readout switch comprising a readout transistor **T5** including a conducting terminal connected to the conducting terminal of the reset transistor **T3**, and including a control terminal.

The Examiner referenced FIG. 4 in He et al. as disclosing a calibration circuit comprising a log select switch **M1<sub>D</sub>/M3<sub>D</sub>** comprising a log select transistor including a pair of conducting terminals connected between the output of the amplifier **AMPD** and the control terminal of the readout transistor **M2<sub>D</sub>**, and including a control terminal to receive a log select signal.

The independent claims have been amended to more clearly define the present invention over the cited prior art references. As illustrated in FIG. 3 in the Applicants'

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application, the readout switch comprises a readout transistor **M2** including a conducting terminal connected to the conducting terminal of the reset transistor **M4** (connection is at the point labeled "pix"), and including a control terminal that is connected to a conducting terminal of the log select transistor **M6**. This same conducting terminal of the readout transistor **M2** is also connected to the photodiode **P** and to the at least one input of the amplifier **A**.

In FIG. 2 of Hagihara, the conducting terminal of the readout transistor **T5** that is connected to the conducting terminal of the reset transistor **T3** is not connected to an input of an amplifier that is also connected to the conducting terminal of the reset transistor **T3**. Instead, FIG. 2 of Hagihara illustrates a different embodiment of a pixel that makes use of the reset transistor **T3**. Column 6, lines 28-31 of Hagihara provides: "On the other hand, a signal  $\phi_{VPS}$  is applied to the source of the MOS transistor **T1**, and also to one end of a capacitor **C** of which the other end is connected to the source of the MOS transistor **T2**." One of the conducting terminals of the readout transistor **T5** is thus connected to the source of the MOS transistor **T2**. The other conducting terminal of the readout transistor **T5** is connected to the output signal line **6**. Since the pixel illustrated in FIG. 2 fails to disclose an amplifier, none of the conducting terminals of the reset transistor **T3** are connected to an amplifier.

In FIG. 4 of He et al., a reset switch is not shown, and the readout transistor **M2<sub>D</sub>** is connected to the photodiode **D<sub>D</sub>**

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via its control terminal and not its conducting terminal as in the claimed invention. Instead, one of the conducting terminals of the readout transistor **M2<sub>D</sub>** is connected to a ground reference, and the other conducting terminal is connected to a control terminal of the log select switch **M1<sub>D</sub>/M3<sub>D</sub>**.

Even if the references were selectively combined as suggested by the Examiner, the claimed invention is still not produced. Accordingly, it is submitted that amended independent Claim 14 is patentable over the Morris et al. patent in view of the He et al. patent and in further view of the Hagihara patent. Amended independent Claims 21 and 31 are similar to amended independent Claim 14. Therefore, it is submitted that these claims are also patentable over the Morris et al. patent in view of the He et al. patent and in further view of the Hagihara patent.

In view of the patentability of amended independent Claims 14, 21 and 31, it is submitted that the dependent claims, which include yet further distinguishing features of the invention are also patentable. These dependent claims need no further discussion herein.

### **III. CONCLUSION**

In view of the amendments to the claims and the arguments provided herein, it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is requested in due course. Should any minor informalities need to be

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addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,



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